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An ecological reconnaissance of four islands in the Archipelago of the Recherche, Western Australia

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Abstract

In 1976 Woody and Mondrain Islands, and in 1977 Wilson, Mondrain and Salisbury Islands were visited for between 1 and 14 days. Lists and, where necessary, collections were made of molluscs (Mondrain I.), plants (all islands), reptiles (Woody I., Mondrain I.), birds (all islands), and mammals (all islands). Many new records for the islands were found; those new for the Archipelago are molluscs (20 species), plants (13 species), reptiles (3 species) and birds (3 species).

Quantitative estimates of abundance of certain land bird species (Woody I., Mondrain I., opposite mainland) show that the two most abundant bird species on Woody and Mondrain Is. were also the two most abundant species in the most comparable mainland habitat studied. Vegetation maps for Woody and Mondrain Is. show the extent of various habitat types and the areas of the dominant plant species. The development of plant communities in terms of exposure and density of burrowing seabirds is discussed.

It is argued that these islands are too large to allow accurate assessment of turnover for plants or reptile species. Turnover is, however, minimal or nonexistent for land birds and mammals.

Island area *per se* and the presence of rock piles probably do not account for the presence of Rock wallabies on only four islands. A new hypothesis is proposed relating their presence on some of the outer islands to more predominant halophytic elements in the floras of the outer islands.

Introduction

The floras and faunas of islands have given mpetus to the development of theories of peciation, coexistence of species and lately the csign of reserves on mainland areas (Main and adav 1971). Isolation is associated not only ith faunas and floras poor in species, but also ith non-random samples of species composition f the fauna and flora on the adjacent mainland. he results are shifts in abundance of various pecies, leading to different coadapted species omplexes from on the mainland.

Islands, particularly small ones, allow the ossibility of complete enumeration of vertebrate nd plant species. This is rarely realized on ainland sites because there are always some pecies in such low numbers that they are over- ooked. More importantly, delincation of thc hape and size of mainland sites is usually arti- cial. Islands therefore offer the advantage hat if baseline studies are thorough enough, ubsequent visitors will have a yardstick with hich to monitor changes, if any, in the occur- ence or abundance of species.

Although many islands around Western Aus- alia have been surveyed, visits have been short often one day) and lists produced deal with at best only a few taxa. Storr (1965) seems to have been the first to pay attention to an ecological reconnaissance of the flora and vertebrate fauna of Western Australian islands. He provided annotated lists and discussion of the vegetation types, flora, reptiles, birds and mammals present on some islands in Houtman Abrolhos. In our opinion, his paper could only have been improved upon by quantifying the abundance of the species on his lists.

In this paper we provide new or detailed information on the vegetation types, plant, reptile, bird and mammal species on four islands in the Archipelago of the Recherche (Fig. 1). In some cases we provide quantitative estimates of abundance of bird species (Mondrain I., Woody I.), macropod species (Mondrain I., Woody I., Wilson I., Salisbury I.) and reptile species (Mondrain I.). A list of additional molluscs found on Mondrain I. is also given. Where possible comparisons are made with the adjacent mainland and other Recherche islands (Fig. 1).

Previous research

Members of the Australian Geographic Society expedition of November 1950 made the first concerted attempt to compile lists of the

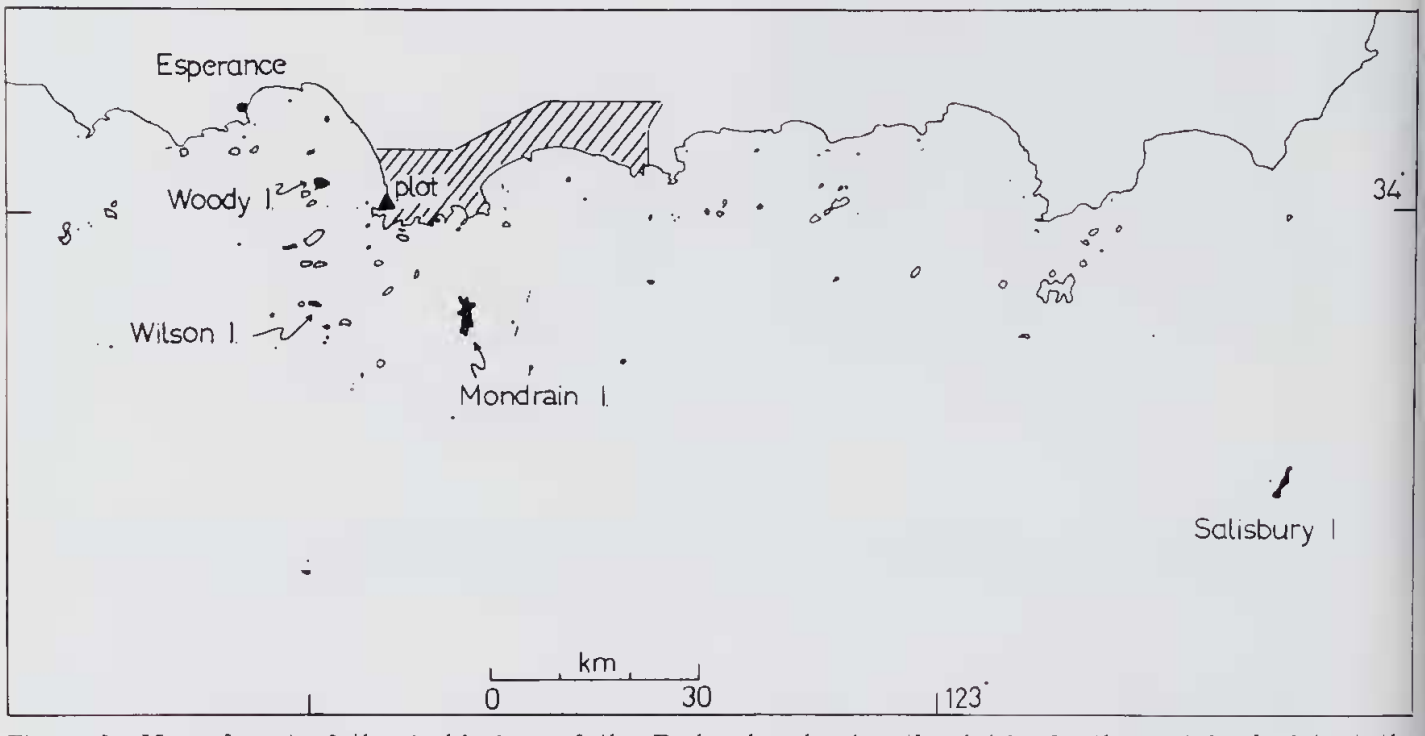

Figure 1.—Map of part of the Archipelago of the Recherche showing the 4 islands, the mainland plot at the east end of Esperance Bay, and Cape Le Grand National Park (shaded area).

flora and fauna for 20 islands, including three (Mondrain, Woody and Salisbury) of the four we visited. Goodsell *et al.* (1976) re-collected on Woody I. over nine days in spring 1975. Nothing has been published on the fauna or flora of Wilson I., though it has long been known that this island has a population of Rock wallabies (Serventy 1953).

Details of our visits

Period of time spent on the islands was as follows: Woody I., 3-16 February 1976; Mondrain I., 16-29 February 1976, 25-27 April 1977; Wilson I., 7 hr. on 25 April 1977; Salisbury I., 3 hr. on 28 April 1977. Black and Abbott worked together on Mondrain in February 1976; otherwise collections and observations were made by Abbott.

Salisbury alone of these islands has limestone present, as a thick aeolianite capping over the whole island except the southern end. The islands are basically granitic-gneissic, and are made up of domes and finger-like projections. For a recent discussion of the geomorphology of such islands, see Twidale (1971).

Plant species

Woody Island (188 ha, 130 m high)

Willis (1963) collected 85 species on 30 November 1950 from the northern side of this island, only about 10 months after a fire had swept over the island. Twenty five years later, Goodsell *et al.* (1976) spent 9 days on the island and collected 121 plant species. Willis recorded 28 plant species that Goodsell *et al.* did not collect. How many of these species actually became extinct in the intervening years? Seven of these species actually represent name changes or different opinions about the names of plants collected in 1950 and 1975. These are *Poa caespitosa, P. porphyroclados* (the first name is the one used by Willis (1953); the second that of Goodsell *et al.* (1976)); *Stypandra imbricata, S. ?glauca; Rhagodia radiata, R. baccata; Crassula miriamae, C. colorata; Leucopogon obovatus, L. revolutus; Gnaphalium involucratum, G. sphaericum; Sonchus oleraceus, Sonchus* species. Of the remaining 21 species, 14 were collected in February 1976. These were *Bromus arenarius, Polypogon monspeliensis, Scirpus antarcticus, Centrolepis strigosa, Tetragonia amplexicoma, Spergularia rubra, Gastrolobium bilobum, Medicago hispidula, Frankenia tetrapetala, Apium prostratum, Platysace compressa, Trachymene pilosa, Myoporum adscendens* and *Cotula cotuloides*. The remaining 7 species which have not been recorded since Willis' visit are indicated in Table 1A. It seems possible these species are now extinct on Woody I., but given the large size of the island they may simply have been overlooked. Future botanical visitors should look out for these 7 species.

Excluding the 7 species listed above that are probable taxonomic equivalents, Goodsell *et al.* (1976) from their examination of the whole island collected 54 species new to the island, many of which are new records for the Archipelago. Thirty of these species were recollected in February 1976. The remaining 24 are listed in Table 1A. Subsequent visitors should especially search for these.

However, in February 1976, 27 species not collected by Willis or Goodsell *et al.* were found on Woody I. (Table 1B). Nine of these are new records for the Archipelago. In all, the total number of species collected from Woody I. is

70 species, which means that this island has he highest plant species/area ratio yet known n the Archipelago. Willis (1953) had suggested hat Sandy Hook I. was the most floriferous sland in the Archipelago; this could still be so s Willis specifically states that his collecting here was incomplete.

Mondrain Island (787 ha, 226 m high)

The parts of this island covered by Willis nd by us are shown in Fig. 2. Clearly, parts f this large island have not been traversed, so that the list of the flora of Mondrain I. must still be considered incomplete. Subsequent visitors should attempt to traverse different parts of the island.

Willis (1953) recorded 40 species that we did not find (Table 2A); in contrast we were only able to add 17 species not listed by Willis for the island (Table 2B). Three of these are new records for the Archipelago. In addition, the *Dryandra* species collected by Willis but not identified to species has been determined as *D. longifolia* R.Br. from our material (A. S. George,

Table 1

Plant species collected on Woody Island

Species collected by Willis, November 1950 (W) or Goodsell, October-November 1975 (G) but not by Abbott, February 1976.

**Bromus hordeaceus* W, G
**Cynodon dactylon* W
**Hodeum marinum* W
**Vulpia bromoides* W, G
**V. membranacea* W, G
Lepidosperma sp. G
L? tuberculatum G
Juncus bufonius W
J. plebeius W
Thysanotus dichotomus G
T. patersonii G
Prasophyllum sp. G
Parietaria debilis W, G
Dryandra nivea G
Petrophile teretifolia G
**Cerastium glomeratum* W
Bossiaea dentata G
**Trifolium campestre* G
**T. tomentosum* G
Geranium solanderi G
Pelargonium littorale G
Comesperma confertum G
Trymalium spathulatum G
Eucalyptus sp. n. G
Melaleucas sp. G
Leucopogon parviflorus G
Myoporum tetrandrum G
Wahlenbergia ? gracilenta G
Dampiera ? coronata G
Scaevola aemula W
Stylidium adnatum G
S. glandulosum G
**Arctotheca populifolia* W, G
Cotula coronopifolia G
Ixiolaena viscosa W, G
Stuartina muelleri W
Waitzia citrina G

Species collected by Abbott, February 1976 but not by Willis, November 1950 or Goodsell, October-November 1975.

Sporobolus virginicus
†Danthonia ? setacea (not *caespitosa*)
**Lolium loliaceum*
**Vulpia myuros*
Lepidosperma viscidum
Juncus maritimus
**Rumex crispus*
**Chenopodium murale*
**C. pumilio*
Threlkeldia diffusa
Lepidium foliosum
*†*Erodium cicutarium*
Boronia albiflora
Comesperma volubile
Stackhousia heugelii
Dodonaea oblongifolia
Spyridium spadiceum
Leucopogon apiculatus
Dampiera prostrata
Stylidium pilosum
†Vittadinia graveolens
*†*Gnaphalium candidissimum*
Angianthus humifusus
A. tenellus
†Quinetia urvillei
†Carduus tenuiflorus
Calocepholus brownii

* Naturalized alien species. † New record for Archipelago.

Table 2

Plant species collected on Mondrain Island

Species collected in November 1950, but not in February 1976.

**Polypogon monspeliensis*
Bromus arenarius
**Briza minor*
Anguillaria dioica
Agrostoerinum scabrum
Thysanotus patersonii
T. dichotomus
Patersonia inaequalis
Microtis unifolia
Catadenia latifolia
Muehlenbeckia adpressa
Calandrinia calyptrata
Lepidium foliosum
Drosera glanduligera
D. macrantha
Crassula bonariensis
Acacia crassiuscula
Chorizema aciculare
Gastrolobium knightianum
Templetonia retusa
Oxalis corniculata
Comesperma volubile
C. confertum
Hibiscus huegelii
Rulingia grandiflora
Hydrocotyle alata
Leuccpogon gnaphalioides
Sebaea ovata
Westringia dampieri
**Solanum nigrum*
Galium australe
Wahlenbergia gracilenta
Goodenia scapigera
Lechenaultia formosa
Dampiera lavandulacea
Stylidium brachyphyllum
Levenhookia pusilla
Cotula coronopifolia
C. australis
**Hypochoeris glabra*

Species collected in February 1976, but not in November 1950.

Sporobolus virginicus
†Schoenus ? subflavus
Lepidosperma gladiatum
Gahnia trifida
Lomandra rigida
Atriplex cinerea
†Rhagodia preissii Moq.
Cakile maritima
Acacia cyclops
Phebalium rude
**Euphorbia paralias*
†Melaleuca radula
†Acrotriche aff. *ramiflora*
Leucopogon apiculatus
L. interruptus
Lobelia heterophylla
Dampiera prostrata
Angianthus humifusus

* Naturalized alien species. † Species new to Archipelago.

pers. comm.). Dr. Willis has pointed out that his record of *Leptomeria cunninghamii* is a misidentification for *L. empetriformis* Miq. The total number of plant species now recorded for Mondrain I. stands at 156.

Wilson Island (123 ha, 80 m high)

R. D. Royce (unpubl.) collected 32 species on Wilson I. on 1 February 1960. Forty species were collected on 25 April 1976 (Table 3). However, 9 of Royce's species were not found by Abbott. These are *Microtis* species, *Verticordia minutiflora*, *Haloragis* species, *Centaurium spicatum*, *Apium prostratum*, *Cotula coronopifolia*, *Gnaphalium* 2 species, and *Sonchus oleraceus*. This island needs to be visited in spring.

Salisbury Island (316 ha, 119 m high)

No botanist has yet collected over the whole of this island. Willis (1953) recorded 25 species, and Abbott failed to find 7 of these: *Parietaria debilis*, *Crassula miriamae*, *Salicornia blackiana*, *Tetragonia amplexicoma*, *Muehlenbeckia adpressa*, *Clematis pubescens*, and *Apium prostratum*. Three species, not listed by Willis, were found: *Dianella revoluta*, *Disphyma blackii*, and *Acacia rostellifera*. However, although *D. blackii* is not in Willis' systematic list, on p. 19 he does state that this species was present on every island visited in 1950. An *Atriplex* collected on this island has been determined as *A. paludosa* sub-species *baudinii* Aellen (P. G. Wilson pers. comm.), so that it is possible that Willis' *A. cinerea* is a misidentification.

Vegetation

Vegetation maps are provided for Woody and Mondrain Islands (Figs. 3, 4). Insufficient time was spent on Wilson and Salisbury Is. to attempt mapping. The maps are a mixture of the key plant species and structural components if no one species could be recognized as dominant.

Woody Island

Goodsell *et al.* (1976) provide a map of vegetation zones based purely on structural criteria, mainly height and canopy cover. We recognized six classes (Fig. 3). The two main ones are low open-heath on the western half of the island and *Eucalyptus*-dominated closed-forest on the sheltered slopes south and east of the summit. Four Eucalypts are present, *E. cornuta* and *E. lehmannii* in exposed places (to 5 m), *E. platypus* var. *heterophylla* (to 10 m) in the closed-forest and *E. angulosa* (to 2 m) scattered throughout open-heath.

The open-heath has an average height of 1-2 m, and closely resembles vegetation of the gentler slopes and plateaux around Mt. Le Grand on the adjacent mainland. It was from this habitat on Woody I. (not investigated by Willis) that the list of plants for Woody I. was increased by half by Goodsell *et al.* (1976). Predominant species are: *Dampiera prostrata*, *Boronia albiflora*, *Lepidosperma leptostachyum*, *L. viscidum*, *Gahnia trifida*, *Calothamnus quadrifidus*, *Isopogon trilobus* and *I. formosus*, *Hakea trifurcata*, *Gastrolobium bilobum*, *Hibbertia* aff. *acerosa*,

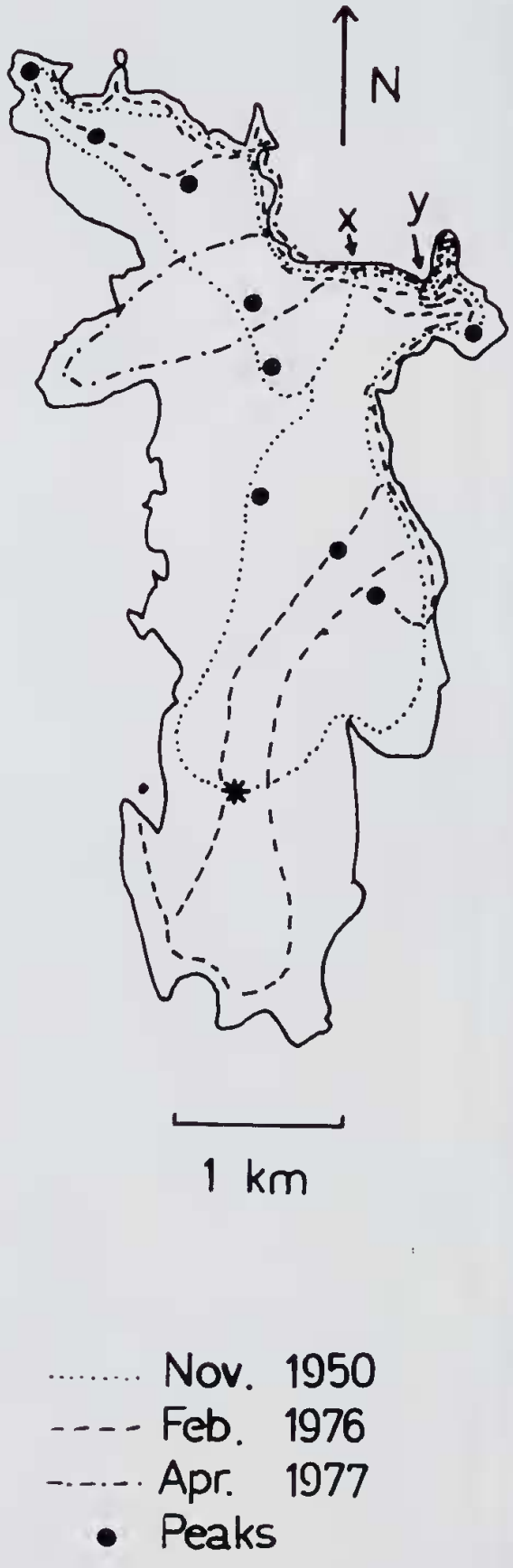

Figure 2.—Areas of Mondrain Island traversed by Willis in 1950 and by Abbott and Black in 1976 and 1977. x and y are the landing places and camp sites in 1950 and 1976-7.

and *Leucopogon rotundifolius*. This habitat is associated with rocky areas with little soil. Burrowing seabirds are absent from such areas, so that levels of phosphorus and nitrogen are probably as low as on similar habitats on the mainland. This habitat is well developed on the central plateau of Mondrain I. (see below) and the southwest part of Bald I., east of Albany.

Melaleuca lanceolata occurs above the shoreline around most of the island, and with *Astartea fascicularis* forms closed-heath intergrading into closed-scrub where sheltered from the southwest. *Acacia acuminata* var. *latifolia* forms stands of closed-heath or closed-scrub, mainly on deeper soils on sheltered parts of the island, and occasionally *Melaleuca elliptica* and

Table 3

Flora of Wilson Island (collected 25 April 1977)

Sporobolus virbinicus
Stipa sp.
Poa australis agg.
Scirpus nodosus
Centrolepis strigosa
C. polygyna
Lomandra rigida
Hakea clavata
H. suaveolens
Muchlenbeckia adpressa
Atriplex ? paludosa subsp. *baudinii*
Rhagodia ? crassifolia
Enchylaena tomentosa
Threlkeldia diffusa
Carpobrotus virescens
Disphyma blackii
Tetragonia amplexicoma
Eutaxia obovata
Bossiaea dentata
Pelargonium australe
Dodonaea oblongifolia
Phyllanthus scaber
Beyeria viscosa
Stackhousia huegelii
Rulingia cygnorum
Pimelea clavata
Eucalyptus cornuta
Agonis marginata
Leptospermum sericeum
Melaleuca globifera
Astartea fascicularis
Platysace compressa
Andersonia sprengelioides
Leucopogon obovatus
**Solanum nigrum*
Myoporum adscendens
Stylidium adnatum
Olearia axillaris
Calocephalus brownii
Senecio lautus

* Naturalized alien species.

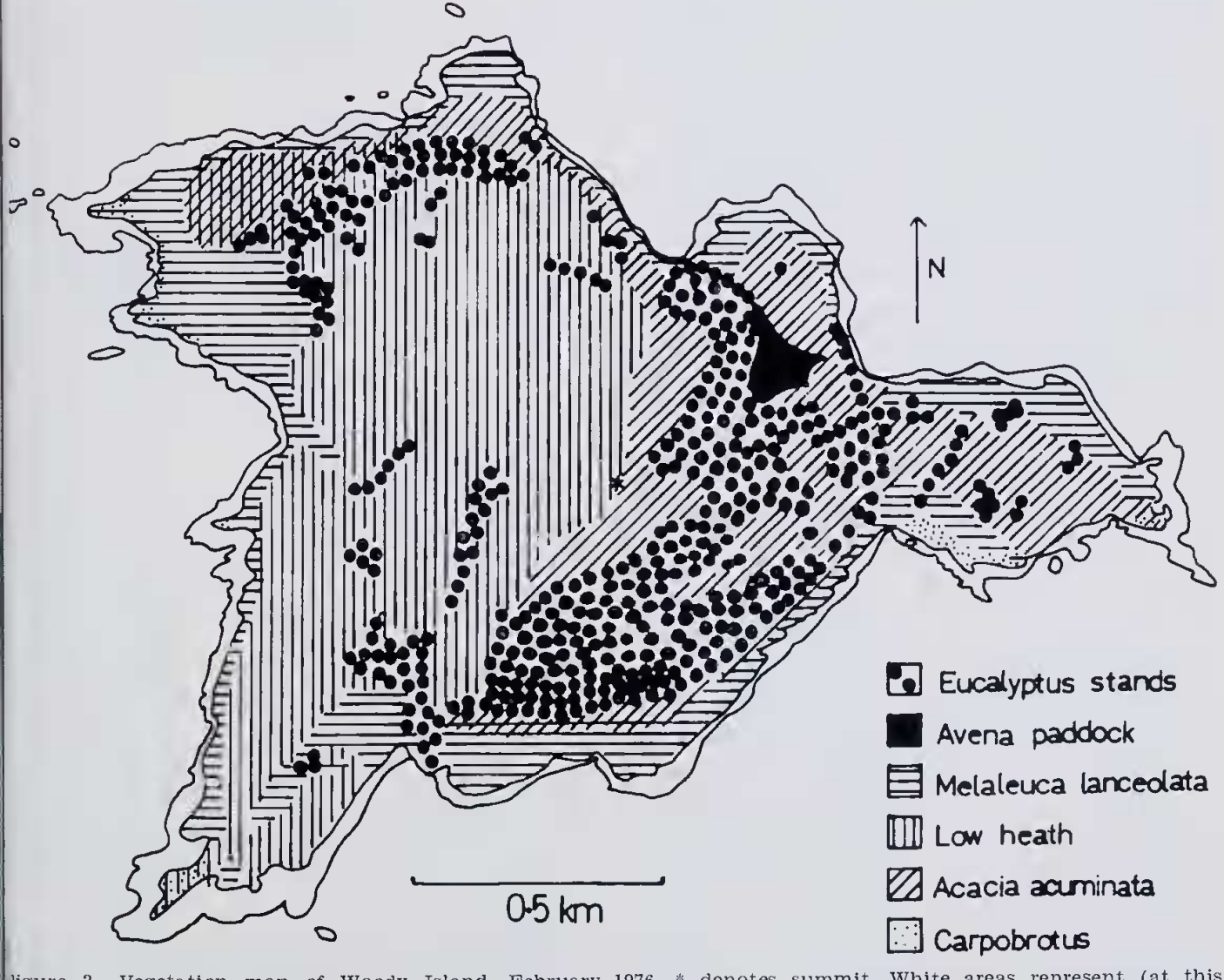

Figure 3.—Vegetation map of Woody Island, February 1976. * denotes summit. White areas represent (at this scale) bare rock.

Acacia myrtifolia mix with it. Rock ledges throughout the island are usually fringed with *Anthocercis viscosa, Hakea suaveolens* and *Agonis marginata* (all to 2 m) and *Platysace compressa* (to 1 m).

In April we flew over all the islands in Esperance Bay at low altitude, and we are convinced that of these islands Woody I. has the most diverse vegetation. There is a small paddock of *Avena barbata* (apparently misidentified as *A. fatua* by Willis) which is being encroached on by bushes of *Albizia lophantha, M. elliptica* and *Lycium ferocissimum.*

Mondrain Island

In contrast to Woody I., the major community on Mondrain I. is dominated by *Melaleuca globifera,* a species that does not occur on Woody I. even though it is common on the adjacent mainland coast. *M. globifera* is associated with *Bossiaea dentata* and *Acacia acuminata* to form 2-3 m high closed-heath or closed-scrub. Patches of Eucalypts occur as closed-scrub (in exposed places) grading into low closed-forest on deeper soils. The dominant species is *E. lehmannii E. angulosa* (as on Woody I.) is common amongst the open-heath and open-scrub on the central plateau (Fig. 4). *E. platypus* and *E. cornuta* were rare. The flora of the open-heath resembles that of the hills around Mt. Le Grand, and not sand-plain as suggested by Willis (1953). The heath is quite open on the shallow soils of the rockier western part of this plateau, but on the eastern side is dense, to 2-3 m. Conspicuous species are: *Dryandra longifolia, Eucalyptus angulosa, Lepidosperma angustatum, Loxocarya flexuosa, Xanthorrhea preissii, Casuarina trichodon, Boronia albiflora, Dodonaea oblongifolia, Hibbertia* aff. *acerosa, Calothamnus quadrifidus, Leucopogon rotundifolius, Gastrolobium bilobum* and *Acacia nigricans.*

Melaleuca lanceolata occurs either as closed-heath on exposed areas or, away from the coast, as low closed-forest under which muttonbirds burrow. Large breaks of *Carpobrotus virescens* herbfield develop in such places. However, *Carpobrotus* and other succulents are most abundant close to the coastline, where *Sporobolus virginicus, Disphyma blackii, Calocephalus brownii, Rhagodia baccata,* and *Atriplex cinerea* merge into wind-pruned *Astartea fascicularis* thickets. Closed tussock-grassland is best developed at the extreme south end.

Around the peaks on the island, *Melaleuca globifera* is still dominant but the usual species of soil pockets around rock slabs (as at Woody I.) are present, including *Kunzea baxteri, Casuarina huegeliana, Borya nitida* and *Lomandra rigida.*

The extensive fires on both Woody and Mondrain (burnt as early as 1802) Islands seem to have had surprisingly little effect, although we have no accurate knowledge of the original vegetation prior to the frequent firing. On Middle I., the largest island in the Archipelago, Willis (1953) reported *Eucalyptus* forest over 10 m tall, and he found comparable examples in the southeast valley on Mondrain. It is regret-

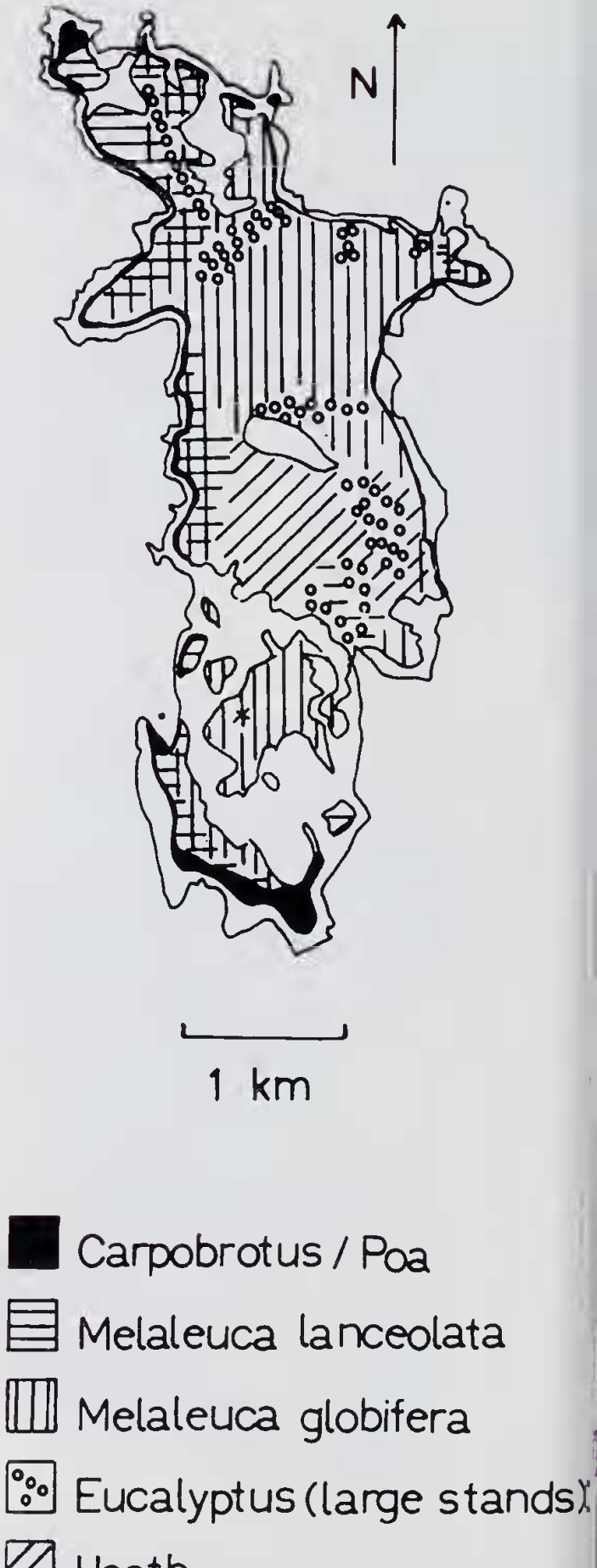

Figure 4.—Vegetation map of Mondrain Island, February 1976. * denotes summit. White areas represent (at this scale) bare rock.

table that analyses of the kind made by Symon (1971) on Pearson Island, South Australia cannot be carried out on any Recherche island.

On Woody I. the *Eucalyptus platypus* stands are even aged, thin boled, and reach 10 m. The original stand was probably of similar height but with trees more widely spaced as on Middle I.

Beard (1975) claimed that the freedom from fire on the islands is of importance in the development of the distinctive island plant communities. However, degree of exposure and the presence of breeding seabirds are at least as important, if not more so. It is the rocky areas on the west or central parts of Woody I., Mondrain I. and elsewhere on Bald I. which seabirds find unsuitable for burrowing that have a flora most resembling the mainland one. Three main factors seem to govern the development of the various plant communities: degree of exposure, type of rock (and soil properties) and presence and density of seabird populations. The relationship of these factors on the Recherche islands is outlined in Fig. 5. The major effect of seabirds on these islands is different from other islands around southwest Australia. The Black-faced Cormorant breeds on one small spot on one island only, and surface-nesting species (Crested Tern, Silver Gull) do not form large colonies. However, five species of burrowing seabirds are widespread (Serventy 1952).

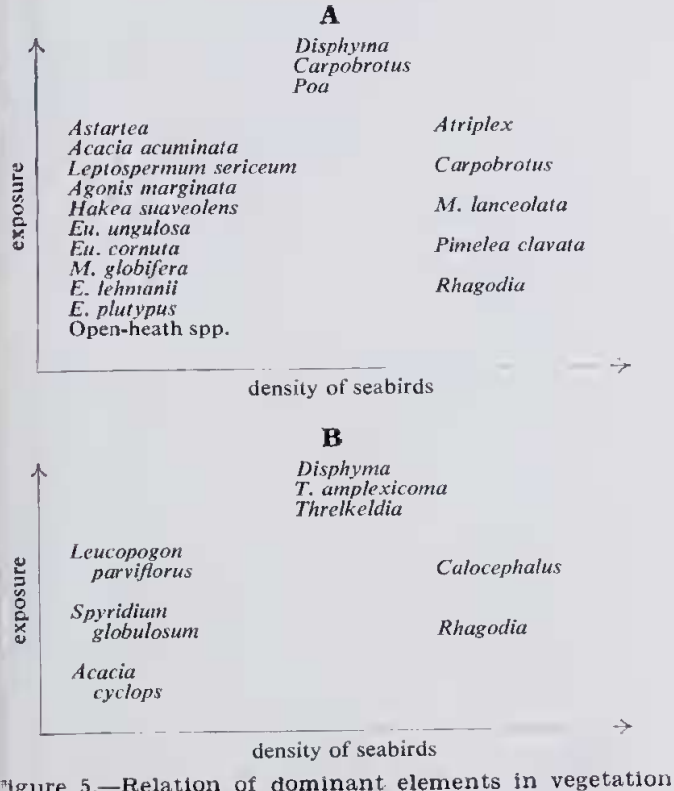

Figure 5.—Relation of dominant elements in vegetation of Recherche islands to exposure (wind, sea spray) and density of breeding sea birds; A.—on soils derived from granite; B.—on soils derived from limestone.

Wilson Island

This island consists of a high (68 m) eastern dome connected by a saddle to a higher dome (80 m) from which a mass of rock projects westwards. On this exposed western projection, vegetation is planed and consists of *Carprobrotus* and *Disphyma* herbfield with occasional low bushes of *Astartea fascicularis*, *Calocephalus brownii* and *Myoporum adscendens*. On the lee side of both peaks patches of *Melaleuca globifera*, *Astartea*, *Agonis marginata* and *Leptospermum sericeum* (2-4 m) occur and there is one small area of *E. cornuta* (2.5 m) behind the 80 m peak. An extensive *Atriplex* plain, burrowed by shearwaters, occurs on the northern slopes of the finger-like part of the island.

Salisbury Island

We can add little to the description given by Willis (1953). The steep northern slopes have vegetation to 1 m and closely resemble those on Michaelmas I. near Albany, though there are differences in plant species present. On the plateau, which consists of weathered aeolianite that is a remnant of old dune deposits formed when the sea was lower, the vegetation reaches 1-2 m and is very wind-pruned.

Molluscs

Following the method of the 1950 expedition of the Australian Geographic Society, we collected "beach-worn specimens, the value of which as a basis for a survey is limited" (Macpherson 1954, p. 55). Nevertheless our collection of dead shells from the sandy shell beaches of Mondrain I. revealed 28 species not recorded for the island previously, of which 20 species are new to the Archipelago (Table 4). We also made extensive collections of living molluscs from accessible intertidal shores around the landing place (northeast cove), and in addition to the living specimens of the species indicated in Table 4, we found living specimens of *Austrocochlea concamerata* (Wood), *Chiazacmea flammea* (Q. & G.), *Dicathais textilosa* Lamarck, *Littorina unifasciata* Gray, *Nerita atramentosa* Reeve, *Patella peronii* (Blainville), *Hipponyx conicus* (Schumacher), and *Patelloida alticostata* (Angas).

Reptiles

Woody Island

In November 1950 the Australian Geographic Society expedition recorded 3 reptile species in their short visit—the gecko *Phyllodactylus marmoratus*, *Egernia kingii* and *Hemiergis peronii* (this last listed by Glauert (1954) as *Lygosoma quadridigitatum*). Goodsell *et al.* (1976) listed 5 species: *Phyllurus milii* (as *Gymnodactylus milii*), *Phyllodactylus marmoratus*, *Egernia multiscutata*, *Ctenotus labillardieri* and *Hemiergis peronii*. However, no specimens were collected, and Dr. G. M. Storr informs us that *E. multiscutata* is probably an error.

Abbott's 2 weeks on Woody I. yielded only 2 lizard species: *Ctenotus labillardieri* and *Egernia napoleonis*, both of which are common. Goodsell *et al.*'s (1976) record of *E. multiscutata* is probably an error for *E. napoleonis*. Presumably the Australian Geographic Society record of *E. kingii* is also an error for this *Egernia*.

Snakes are definitely absent from Woody I.

Table 4

Mollusc species collected on Mondrain Island in February 1976 which were not collected in November 1950

Family	Species
Chitonidae	**Clavarizona hirtosa* (Blainville)
Haliotidae	*Haliotus laevigata* Donovan
	H. cornicopora Péron
	†*H. cyclobates* Péron
Fissurellidae	†*Fissurella nigrita* Sowerby
Patellidae	**Patellanax laticostata* (Blainville)
Acmaeidae	†**Patelloida nigrosulcata* Reeve
	†**Notoacmaea onychitis* (Menke)
	†**N. septiformis* (Quoy & Gaimard)
Trochidae	*Phasianotrochus bellulus* Dunker
	Cantharidus lehmanni Menke
	C. pulcherrima Wood
Phasianellidae	†*Tricholia gabiniana* Cotton & Godfrey
	†*Orthromesus angasi* (Crosse)
Hipponicidae	†*Antisabia foliacea* (Quoy & Gaimard)
Cypraeidae	†*Cypraea piperita* Gray
	†*C. comptoni* Gray
Cassidae	†*Cassis fimbriata* (Quoy & Gaimard)
Cymatiidae	†*Charonia lampas rubicunda* Perry
	†*Cymatiella lesueuri* Iredale
Columbellidae	†*Macrozafra cominelliformis* Tate
	†*Dentimitrella lincolnensis* Reeve
	†*D. pulla* Gaskin
Mitridae	†*Mitra deshayesi* d'Orbigny & Recluz
Conidae	†*Conus coccens* Reeve
Siphonariidae	†**Siphonaria baconi* (Reeve)
Lymnaeidae	†*Lymnaea lessoni* Deshayes
Bulimulidae	*Bothriembryon rhodostomus* Gray

* living specimens; all others drift shells. † new record for Archipelago.

Mondrain Island

Two species of snakes and 9 lizard species were found on Mondrain I. (Table 5). Although the Death Adder *(Acanthophis antarcticus)* was recorded in November 1950, it was not met with in February or April. The white-lipped snake *Denisonia coronoides*, apparently collected in 1921, was not recollected in 1950 or 1976 and may be an error. Carpet snakes ranged from 120-175 cm in length, and were usually found on rock, from within a few metres of the sea up into the heath-covered plateau. Crowned snakes (length 25-50 cm) were noted mainly on leaf litter.

Table 5

Counts of Reptiles seen during 10 sunny days at Mondrain Island in February 1976

	Species		No. seen
Snakes	*Python spilotus*, Carpet Snake		6
	**Denisonia coronata*, Crowned Snake		15
Lizards	**Amphibolurus ornatus*	adult	134
		juv.	71
	†**A. muricatus*	adult	9
		juv.	6
	**Tiliqua rugosa*, Bobtail		4
	**Ctenotus labillardieri*		32
	†**Cryptoblepharus virgatus clarus*		4
	†**Leiolopisma trilineatum*		1
	Egernia kingii		23
	**Phyllodactylus marmoratus*		1
	Phyllurus milii		1

†new record for the Archipelago.

*Collected, lodged in Western Australian Museum.

The Australian Geographic Society expedition found 8 lizard species. Three of these, *Egernia napoleonis* (as *E. carinata*), *Hermiergis peronii* (as *Lygosoma quadridigitatum*) and *Leristes frosti* (as *Ablepharus elegans*)) were not recorded by us. However, we recorded 3 species not only new to the island but also new to the Archipelago (Table 5). The two *Amphibolurus* species lived in different habitats with only slight overlap –*A. ornatus* on rock slabs throughout the island and *A. muricatus* on leaf litter under vegetation and up branches. *Ctenotus labillardieri* was found in leaf litter, under rocks and on rock slabs. King's skink was found mainly close to the shore. We did not find any amphibia on Mondrain I. (where one species was recorded in 1921), even though we specifically searched many rock pools near the summit.

There was insufficient time to attempt a complete search for reptiles on Wilson and Salisbury Is. However, no snakes were observed on either island.

Birds

Mist-netting was carried out on Woody and Mondrain Is. in February 1976. The quantitative estimates of abundance of the bird species trapped are shown in Table 6. The following list records bird species present but not netted on both these islands, and all species noted on Wilson and Salibury Is. New island records of species are indicated. Seabirds on Woody and Mondrain Is. are more fully described, with maps of their distribution, by Abbott (in press).

Table 6

Relative abundance of mist-netted bird species on two Recherche islands and one adjacent mainland locality

Species	Woody Island		Mondrain Island		East End of Esperance Bay			
					dune scrub*		heath	
	N	RA	N	RA	N	RA	N	RA
rown Quail	14	3·7	+	+	—	—	—	—
rush Bronzewing	1	0·3	—	—	—	—	—	—
ock Parrot	9	2·4	+	+	+	+	—	—
Velcome Swallow	7	1·8	16	4·9	+	+	2	4·7
potted Scrub-Wren	—	—	4	1·2	2	3·2	1	2·3
iolden Whistler	4	1·0	3	0·9	—	—	—	—
potted Pardalote	+	+	—	—	1	1·6	1	2·3
ilvereye	67	17·5	36	11·0	51	82·3	49	114·0
inging Honeyeater	9	2·4	4	1·2	—	—	—	—
White-bearded Honeyeater	59	15·5	93	28·4	1	1·6	54	125·6
pinebill	—	—	—	—	—	—	3	7·0
rown Honeyeater	—	—	—	—	—	—	1	2·3
irey Butcher bird	—	—	—	—	—	—	1	2·3
otal No. net hours	382		327		62		43	
letting dates	4–14/2/1976		17–26/2/1976		19–24/10/1976			

I No. trapped of each species
.A Relative number of birds trapped (per 100 hr. of netting)
- present but not netted
– absent
this habitat is not represented on Woody and Mondrain Is.

Eudyptula minor Little Penguin.—Woody I., not seen but presence indicated in one place by characteristic guano; Mondrain I., about 5-10 birds braying near camp site, both visits. Feathers were noted at various places along the north coast in April 1977; Salisbury I., one carcase found, and moult feathers elsewhere, amongst limestone boulders at shore (new record).

Coturnix ypsilophora Brown Quail.—Woody I., very common, especially in *Avena* paddock. Even more birds were netted than recorded in Table 6 as this species can extricate itself from mist nets; Mondrain I., rare; seen everyday but patchily distributed. Tunney's record of *Turnix varia* on Mondrain (Serventy 1952) may refer to this species.

Phaps elegans Brush Bronzewing.—Woody I., seen everyday. Rare in heath, commonest near *Avena* paddock; Wilson I., two seen.

Pelagodroma marina White-faced Storm-Petrel. —Woody I., burrows found on southeast coast; Mondrain I., a few burrows on south side of peninsula on west coast.

Phalacrocorax fuscescens Black-faced Cormorant.—Woody I., 2-5 usually loafing on rock near extreme east tip of island; Mondrain I., one near landing place and one on rock, 3 m high, near peninsula on west coast.

Hydroprogne caspia Caspian Tern.—Woody I., one offshore, north coast, most days; Mondrain I., one offshore, north coast, February only.

Sterna bergii Crested Tern.—Mondrain I., 14 on north-central point in February; one at same place, April and one near peninsula on west coast.

Larus novaehollandiae Silver Gull.—Woody I., up to 4 present; Mondrain I., 4 at north-central point in April; Wilson I., 20 birds around island.

L. pacificus Pacific Gull.—Woody I., 2-4 seen most days; Mondrain I., one with 2 immatures in February; in April a few around island. On the north coast of this island we counted the number of shells at recently used Pacific Gull anvils where these birds apparently dropped shells of the molluscs *Turbo torquata* and *Dicathais textilosa* frequently and of *Haliotis roei* and *Patellanax laticostata* rarely. In order to assess whether these gulls were selecting particular gastropods as prey, we counted shells of gastropods stranded above the high tide in areas of shell rubble and sand along the same stretch of shore as the anvil sites. However, the abundance of such dead remains may not be directly related to the numbers of living animals because of differences between species in mortality rates and shell disintegration rates. Nevertheless, the relative abundances of the stranded shells matched well with Black's impressions of abundances of living gastropods in the adjacent intertidal zone, where *P. laticostata* was very abundant. (In particular two samples of area 10.4 m^2 and 11 m^2 had densities of 8.9 and 9.0 individuals/m^2.)

The results (Table 7) clearly show that Pacific Gulls selected *Turbo* and *Dicathais*. *Haliotis* and *Patellanax* always cling tightly to the rock and increase their grip when disturbed. On the other hand *Turbo* and *Dicathais* withdraw into their shells when disturbed and could therefore be carried off easily. We did not observe any gulls actually capturing gastropods or dropping items on the anvil sites. Wilson I., 4 immatures and 2 adults seen. Salisbury I., a few offshore at landing place.

Haematopus fuliginosus Sooty Oystercatcher.— Woody I., 3 around island; Mondrain I., 5 seen along north shore; Wilson I., one bird on south side; Salisbury I., 2 near landing.

Table 7

Gastropod remains at 14 Pacific Gull anvils on granite shores, and at 8 areas of strand-line drift, on Mondrain Island. February 1976

	Haliotus roei	*Patellanax laticostata*	*Turbo torquata*	*T. jourdani**	*Campanile symbolica**	*Dicathais textilosa*
Gull anvil	3	4	97	0	0	75
Strand-line drift	27	289	35	4	1	19

χ^2 test for independence (omitting*) = 333

Tringa hypoleucos Common sandpiper.—Mondrain I., one at north-central point, February (new record for island).

Ardea novaehollandiae White-faced heron.—Mondrain I., one bird at north-central point, February.

Cereopsis novaehollandiae Cape Barren Goose.—Woody I., one pair, observed feeding in *Avena* paddock and on north shore; Mondrain I., always one pair on north shore, and 5 seen at south end; Wilson I., 4 seen together on north side, and another 3 on south side.

Accipiter fasciatus Brown Goshawk.—Woody I., 2 birds (one an immature male) in *E. platypus* forest. One bird killed and ate a rock parrot in mistnet.

Haliaetus leucogaster White-breasted sea eagle.—Woody I., one overhead on 9 February; Mondrain I., one in April, and one adult and one immature in February; Wilson I., 2 pairs seen. No nests were located on these islands.

Falco peregrinus Peregrine Falcon.—Mondrain I., one bird, glimpsed briefly in centre of island on 26 February, may have been of this species.

F. cenchroides Kestrel.—Mondrain I., one at northwest end in February.

Tyto alba Barn Owl.—Woody I., one bird was seen at 4 a.m. in the *Avena* paddock on 16 February.

Neophema petrophila Rock Parrot.—Woody I., common about *Avena* paddock, where feeding on *Lycium* berries; Mondrain I., feeding amongst *Rhagodia* bushes; Wilson I., heard only.

Cacomantis pyrrhophanus Fan-tailed Cuckoo.—Mondrain I., two birds seen near camp in April (new record for Archipelago).

Hirundo neoxena Welcome Swallow.—Woody I., nests found in caves; about 30 birds seen overhead at dusk several days; Mondrain I., common; Wilson I., a few.

H. nigricans Tree Martin.—Woody I., 12 birds over *Avena* paddock on 15 February.

Coracina novaehollandiae Black-faced Cuckoo-Shrike.—Woody I., one bird seen 11 February; Mondrain I., 2 birds seen northwest end in *Eucalyptus* forest in February. (New record for Archipelago.)

Pachycephala pectoralis Golden Whistler.—Woody I., in *E. platypus* forest only; Mondrain I., in thickets of no great height; Wilson I., one brown-plumaged bird in *Melaleuca globifera* stand, probably vagrant.

Sericornis maculatus Spotted Scrub-wren.—Mondrain I., widespread; Salisbury I., in heath on plateau as well as thinly vegetated slope down to landing place.

Zosterops lateralis Silvereye.—Woody I., feeding on *Lycium* berries and *Muehlenbeckia* fruits, as well as nectar from *E. platypus* flowers; Mondrain I., feeding on nectar from *M. lanceolata* flowers; Wilson I., only two seen; Salisbury I. rare.

Meliphaga virescens Singing Honeyeater.—Woody I., feeding on *Lycium* berries; Mondrain I., feeding on *M. lanceolata* flowers; Wilson I., a few present.

Phylidonyris novaehollandiae White-bearded Honeyeater.— Woody I., common in *E. platypus* forest, where feeding on nectar; also feeding at *M. elliptica* and *M. lanceolata* flowers. Only one bird seen in open-heath; Mondrain I., feeding from *M. lanceolata* flowers and *E. lehmanni* flowers.

Pardalotus punctatus Spotted Pardalote.—Woody I., one pair seen over several days in *E. platypus* forest; possibly vagrant (New record for Archipelago).

Anthus novaeseelandiae Pipit.—Wilson I., one bird seen.

Corvus coronoides Raven.—Woody I., usually 2-3 recorded, but 15 was most recorded at one time; Mondrain I., 2 seen each day; Wilson I., 2 present.

The quantitative estimates of abundance of 'catchable' birds (Table 6) show that the Silvereye and White-bearded Honeyeater were the most abundant species on Woody and Mondrain Is. and in the heath at the east end of Esperance Bay (*Calothamnus quadrifidus* and *Melaleuca globifera* dominant). The other mainland habitat studied was on Quaternary sand dunes behind the beach, a habitat not represented on Woody or Mondrain Is.

Mammals

Two *Rattus* species (one introduced), 2 macropod species (one introduced) and 2 species of seals were recorded. No trapping was carried out.

Woody Island

Rattus rattus.—This species was abundant at the campsite (edge of *Avena* paddock). At night scores were seen in this paddock, where they fed on *Avena* seeds and table scraps. They were

ery bold. *R. rattus* has apparently replaced . *fuscipes* on Woody I., as the latter species as collected there in 1921 (Taylor and Horner 973).

Macropus fuliginosus.—Probably introduced. A skull was picked up on the shore north of the *vena* paddock (lodged in the Western Australian Museum); a joey was seen several times in his paddock, and occasionally another larger animal was disturbed at various places in the astern half of the island.

No seals occur around this island. Goodsell *et al.* (1976), who ran various trap lines, recorded *Pseudomys albocinereus* on Woody I.

Mondrain Island

Rattus fuscipes.—Very rare. Only 2 individuals were seen, both near campsite. One of these drowned in a bucket of water and is lodged in the collections of the Western Australian Museum. Our table scraps were ignored.

Petrogale lateralis Rock wallaby.—These were conspicuous and 67 were counted over our 10 sunny days on the island in February (Table 8). We saw animals at all times of the day. Most of our sightings were along the sloping granite shore and the adjacent piles of boulders which provided refuges for the animals (Table 8). The group of 7 animals was amongst boulders along the shore where there was a seep of freshwater where vegetation met the rock. However, we saw animals far from the shore near the central part of the island on granite outcrops and amongst boulders there. Faeces were seen about the summit. The central heath habitat was the only location in which we failed to see Rock wallabies or find their remains. Many skulls were collected, and have been lodged in the Western Australian Museum. In April 1977, Rock wallabies seemed to be less conspicuous than in February 1976 (Table 9).

In February, close to the shore, Rock wallabies were observed chewing the succulents *Disphyma blackii* and *Carpobrotus virescens*, and *Atriplex cinerea* at the extreme north western point. In April, *Carpobrotus* was found freshly chewed, and *Myoporum adscendens* was strip-barked.

Neophoca cinerea Australian Sea Lion.—These were seen, in February, occasionally in the water at the landing place, and on the tip of the north central point (2 animals). A skull and old faeces were found about half way down the east side of the island close to the shore. In April, 4 were on the same north central point, and one appeared briefly at the landing place but did not land. No individuals or old faeces were found amongst the vegetation of the island. This is a common trait of this species.

Arctocephalus forsteri New Zealand fur seal.—One on north central point in February, and 2 were seen close to this point on a boulder islet in April.

Wilson Island

Petrogale lateralis.—The most abundant (and conspicuous) population in the Recherche islands visited was found on Wilson I. (Table 9). Plant species eaten were *Poa australis* tussocks, *Carpobrotus virescens*, *Lomandra rigida* and *Myoporum adscendens* (bark).

No seals, or their old faeces, were found.

Salisbury Island

Petrogale lateralis.—Because this island is the third largest in the Archipeligo, and because so little time was spent there, any count of wallabies is probably worthless (Table 9). However, in qualitative terms, the population here was intermediate in abundance between those of Mondrain and Wilson Is. in April 1977. The leaves of *Poa australis* and *Olearia axillaris* were found chewed, and *Myoporum adscendens* was ring-barked.

Arctocephalus forsteri.—Nine, including one pup, were seen on the granite platform near the landing. There are many large caves at the base of the island (formed by nick points in limestone, and the openings are usually protected by debris). Dr. G. Maynes reported about 20 more seals farther south of the landing.

Discussion

Biogeographical considerations

No plant, mollusc, reptile, bird or mammal species is known to be restricted to any of the Recherche islands—species either occur on the mainland or on other islands along southern Australia. However, the archipelago provides a largely neglected 'natural laboratory' (Main 1967) in which to carry out ecological, evolutionary, morphological and genetic studies. Very importantly, much of the mainland opposite the Archipelago is reserved as National Park, so that mainland/island comparisons of ecological/evolutionary interest are still possible. This desirable feature is becoming less available elsewhere in southwest Australia. A variety of animals occurs abundantly on enough islands and on the mainland to make such studies feasible (e.g. *Amphibolurus ornatus*, Crowned snake, two macropod species).

Several species of reptiles and mammals which are now extinct on the adjacent mainland still occur on some of the islands. Three of the lizard species collected by us on Mondrain I.

Table 8

Sightings of 67 Rock Wallabies during 10 sunny days at Mondrain Island in February 1976

	Vegetation	Granite Outcrops	Boulders in vegetation	Boulders at shore	Rock at shore
No. single individuals	7	5	3	15	6
No. individuals in groups	0	0	2,2,3	2,2,2,3,5,7,	3

Table 9

Numbers of Rock Wallabies seen on three Recherche islands

Island	No. seen	Period of observation	Island area (ha)
Mondrain	67	10 sunny days, February 1976	787
Mondrain	7	2 days, April 1977	787
Wilson	37	4 hours, 25 April 1977	123
Salisbury	5	1·5 hours, 28 April 1977	316

have not been recorded for Cape Le Grand National Park (Chapman and Dell 1975). *Python spilotus* is rare in this Park but common on Mondrain I. Rock wallabies and Tammars, apparently now extinct in the Park (Kitchener and Chapman in Kitchener *et al.* 1975), are abundant on several islands (Serventy 1953, this study). The Cape Barren Goose, not recorded from the Park, occurs on many islands (Serventy 1952, this study).

The distribution of snakes throughout the Archipelago (Serventy in Glauert 1954) would repay further study. The Carpet snake is known only from Mondrain I., the Dugite only from two islands in the west group of islands, the Crowned Snake from three widely separated islands, with the Death Adder having been definitely observed on five widely separated islands. The largest island in the Archipelago, Middle I., has no snakes. The Tiger Snake, one of the most abundant snakes in Cape Le Grand Park (Chapman and Dell in Kitchener *et al.* 1975) is not known from any Recherche island, and the Death Adder was not recorded from the Park.

Insular distribution of Rock wallabies

Of about 220 above-water land masses in the Archipelago, 20 have an area of 90 ha or more. The smallest island with a macropod population is Combe (area 93 ha). Only another 5 islands have macropod populations. The interesting problem of why the remaining 14 islands do not have either the Rock wallaby or Tammar has not been addressed before. All of these appear to be large enough to support the Rock wallaby, which is smaller than the Tammar so that more reproductive units would be available. Main (1961) and Main and Yadav (1971) suggest that indestructible rock-piles allow Rock wallabies to persist on an island as small as Combe. However, Abbott has sailed close-in down the west shore of Combe, and in his opinion, the island does not appear to have any more rock piles than, for example, Woody I. It may be useful to examine more closely the floras of the 4 islands possessing Rock wallabies to see whether plant species preferred by Rock wallabies are rare or absent from the 16 islands without Rock wallabies.

Our observations suggest that the succulents *Disphyma, Carpobrotus* and *Atriplex* with *Poa* tussocks and the common *Olearia* and *Myoporum* are important elements in the diet of Rock wallabies. An island with a flora and vegetation made up entirely of these species should therefore have a better chance of keeping a viable Rock wallaby population than an island covered with heath or *Eucalyptus* forest (such as Woody I. or Sandy Hook I.). Also considerations of wave action suggest that islands more offshore should develop a more halophytic flora and vegetation than inshore islands because most sclerophyllous species do not persist under exposed maritime conditions (Abbott, unpublished). This may help to explain why Rock wallabies are on the older islands (Table 10) in the Archipelago (Salisbury, Wilson, Combe and Mondrain) and not on the younger ones (e.g. Middle, North Twin Peaks, Woody, Observatory Is.).

Some of the islands listed in Table 10 should prove suitable sites on which to liberate Rock wallabies. Introduction in 1960 of one male, 4 females and one unsexed individual of the Rock wallaby to the Middle and South Pearson Islands from North Pearson I. (South Australia) led to a population of 90-112 animals by 1969 (Thomas and Delroy 1971).

Turnover.

Studies of turnover (the frequency with which species become extinct, or immigrate) are becoming popular (Diamond 1969; Lynch and Johnson 1974; Abbott 1977). Such studies have value only if surveys are thorough and complete, and obviously the reliability of turnover studies depends on the taxon considered and the size of the island. If islands are too large, species will be overlooked (and mistakenly assumed to have become extinct), or be regarded as immigrants when they have been present all the time. Islands such as the 4 studied in this paper seem to be too large to make estimates of turnover of plant or reptile species reliable enough. However, such studies with land bird and mammal species are entirely appropriate.

As the Australian Geographic Society expedition spent only some 2 hours on Woody I., we do not have a sufficient baseline of the birds present in 1950. However, we can compare Goodsell *et al.'s* (1976) list (October-November 1975) with Abbott's visit of February 1976. Goodsell *et al.* recorded 14 land bird species of which 2 (Swamp Harrier and Kestrel) were represented by single individuals. Abbott recorded 15 species. Three of these (Tree Martin, Spotted Pardalote and Black-faced Cuckoo-shrike) were new and were probably vagrant, except possibly the Spotted Pardalote.

On Mondrain I., Serventy (1952) recorded 8 species of land birds. We recorded 13 species of which the Brown Quail, Cape Barren Goose, Kestrel, Fan-tailed Cuckoo (April only), and

Table 10

Area, elevation and age (as indicated by depth of surrounding water) of Recherche islands apparently large enough to support a species of Macropod

Island	Area (ha)	Elevation (m)	Rising from Sea (m)**
†Middle	1 110	175	33
*Mondrain	787	226	45
*Salisbury	316	119	82
†North Twin Peak	306	187	18
Figure of 8	273	113	45
Sandy Hook	268	140	c.35
Boxer	192	88	42
Woody	188	130	36
Long	152	103	c.29
*Wilson	123	80	c.49
Remark	116	220	c.29
South Twin Peak	115	186	c.27
Frederick	106	88	c.29
Hood	106	76	c.45
Corbett	99	124	c.50
Observatory	96	78	29
Gunton	94	116	40
Charley	93	108	24
*Combe	93	22	60
Howe	90	82	c.45

* Rock Wallaby present. These islands are also some of the oldest in the Archipelago.
† Tammar present
** A depth of e.g. 82 m signifies that island formed about 15 000 yr. B.P. (Main 1961). Sea level continued to rise at the rate of c. 1 m per century.

Black-faced Cuckoo-shrike (February only) were new. The first 2 probably breed on the island.

Serventy (1952) recorded 4 land bird species on Salisbury I. in November 1950 whereas Abbott recorded only 2 in April 1977, but in view of the shortness of these visits, these differences mean little. For the mammals, the same 2 species of land mammals were recorded on Mondrain I. in 1921 and 1976. On Salisbury I., the Rock wallaby and New Zealand Fur Seal were recorded in 1950 and 1977.

Thus the breeding bird and mammal faunas show remarkable stability over time.

Relevance to design of reserves on mainland

It is no surprise that small, circumscribed areas have fewer species than areas of equal size that are part of a larger area. The majority of species in a community are the rare ones (Preston 1962; Williams 1964), and in a mainland situation disappearance of these rare species from a small area can usually be made good by dispersing individuals. This process of recolonization on islands is attenuated by a stretch of water—a bird species that stops to rest will drown, a fruit or seed of many plant species will sink or if it reaches an island, may not germinate.

Certain bird species (e.g. Hawk, Raven, White-bearded Honeyeater, Silvereye, Rock parrot, Swallow, Spotted pardalote, Black-faced Cuckoo-shrike, Cuckoos) are capable of sustained flight and these species are present on or have been recorded on some of the Recherche islands. Other bird species (Golden Whistler, Scrub-wren, Singing Honeyeater) are not known to make extensive movements on the mainland, and so it seems probable that these species were originally on the Recherche islands when they were hills on the mainland, and have survived on some islands to the present day.

The Recherche islands and the adjacent mainland present a situation that is little faced by authorities today but which will become critical over the next 100 years in Western Australia. This is, given that clearing for agriculture will continue, is it better to retain a few large tracts of native habitat or the equivalent area in many, smaller reserves? (Wilson and Willis 1975; Simberloff and Abele 1976.) Both seem to be required. The latter alternative by itself does not guarantee the persistence of high diversity communities because of high extinction rates of species in small areas. However, the former leads to reserves with many species of which only a few are abundant. Furthermore in an Archipelago, species (e.g. Rock wallabies, various snakes) that would otherwise become rare in larger areas can persist, perhaps because of reduced interspecific competition, or predation.

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